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NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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GROWING MEDIA AFFECT SIZE OF CONTAINER-GROWN RED PINE

ABSTRACT.--Red pine seedlings were grown in nine different soil media and in two types of containers in a greenhouse. Growth differed significantly among the media after 16 weeks, with the largest seedlings produced in a peat-vermiculite mix.

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Growing tree seedlings in various types of containers is becoming common in many parts of the world. Although the size, shape, and composition of the containers have been found to significantly affect seedling growth (Scarratt 1972, Funk 1971), little is known about the effects of the soil medium on seedling development. Various artificial mixtures have been used in horticulture and some produce seedlings superior to those grown in commonly used loam potting soils (Wildon and O'Rourke 1964). Other advantages offered by artificial mixtures are: light weight, uniform composition, and freedom from insects and disease.

A study was begun in 1971 to compare nine growing media for the production of red pine in Japanese paper pots[1] and BC/CFS styroblocks[2] (fig. 1). The nine media were: (1) peat moss-vermiculite-arcillite[3] (1:1:1), (2) peat moss-vermiculite (1:1), (3) peat moss-arcillite (1:1), (4) peat moss-sand (1:1), (5) vermiculite-arcillite (1:1), (6) peat moss, (7) arcillite, (8) vermiculite, and (9) a potting soil made up of peat moss-sand-loam (1:1:2). The seed, from an open-pollinated Michigan source, was sown in the containers in late spring in a greenhouse where the temperature was maintained above 65° F. Both growing medium and container type were replicated 18 times in a completely randomized design. Seedlings were watered often enough to avoid moisture stress and fertilized about every 10 days with a water soluble 30:10:10 fertilizer with micronutrients. Natural light was supplemented to provide a 20-hour photoperiod. Sixteen weeks after seeding, shoot weight, and stem diameter were measured on all surviving seedlings.

Germination was rapid in all containers during the first 2 weeks after seeding and was essentially complete in 20 days. Neither germination nor survival varied significantly among treatments. At the last

[1] *Individual paper tubes, open at both ends and glued together in a honeycomb fashion. Dimensions are approximately 1-1/2 inches by 6 inches.*

[2] *A rectangular block of foamed polystyrene with tapered, rounded cavities. Drainage is provided by a small hole at the lower end of each cavity. Dimensions are approximately the same as the Japanese paper pots.*

[3] *A montmorillonite clay which has been calcined at high temperatures and ground into a particle size of 10-40 mesh.*

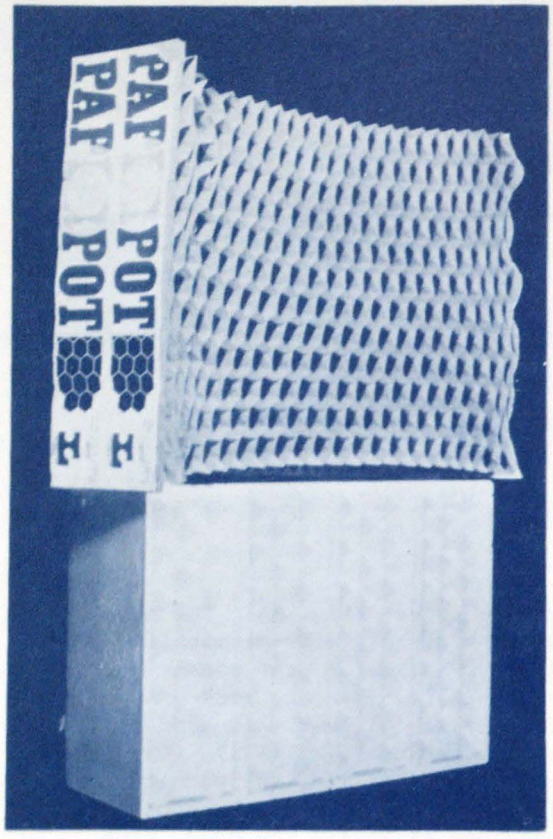

Figure 1.--*Paper pots and the BC/CFS styroblock.*

count, average survival was 46 percent. Mortality appeared to be due mainly to the high temperature in the greenhouse so survival could probably have been increased with adequate cooling.

Differences in seedling growth among the various media became evident after about 4 weeks, especially in the styrofoam containers, and by the end of the study a pattern had been established (fig. 2). The largest seedlings grew in equal parts of peat and vermiculite (fig. 3). Shoot length and weight, root weight, and stem diameter of seedlings from this mix were significantly greater (0.05 level) than for seedlings produced in any other medium. The other media containing peat moss (except for the peat moss and sand mix) produced larger seedlings than media without peat moss, but did not differ statistically from each other. In the paper pot containers, seedlings grew slightly larger in the peat and vermiculite mix than in

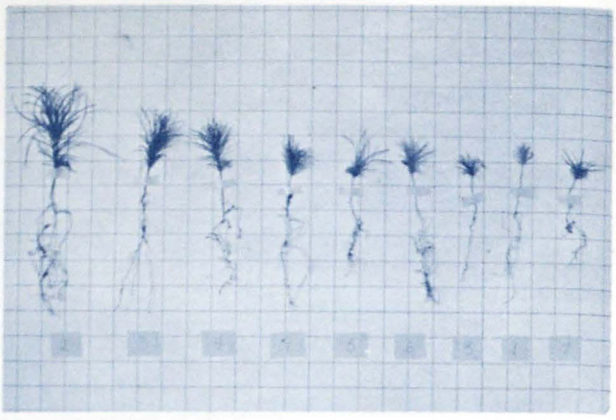

Figure 2.--*Typical red pine seedlings produced in the following soil media. Left to right: peat-moss-vermiculite (1:1), peat moss-vermiculite-arcillite (1:1:1), peat moss-arcillite (1:1), peat moss-sand-loam (1:1:2), vermiculite-arcillite (1:1), peat moss, arcillite, peat moss-sand (1:1), vermiculite. (Background squares are 1 inch.)*

other mixes but differences among seedlings in all media were small and not as consistent as those found in the styrofoam.

In an attempt to further characterize the various soil media and to determine factors that might account for the differences in seedling growth, drying rate, pH, and cation exchange[4] were determined for each medium. The peat moss-vermiculite combination had the highest cation exchange capacity (143 meq/100 g); peat moss-vermiculite-arcillite had the second highest value. The peat moss-sand mix ranked last with a capacity of only about 7 meq/100 g.

The pH of the different mixes was measured in containers that had received the same amounts of water and fertilizer, but contained no seedlings. The values ranged from 5.0 to 5.6 for the peat moss-vermiculite, peat moss-vermiculite-arcillite, peat moss-arcillite mixes, and

[4] *Determined by saturating the media with sodium acetate, displacing the adsorbed sodium with ammonium acetate, and measuring sodium concentration by flame photometry.*

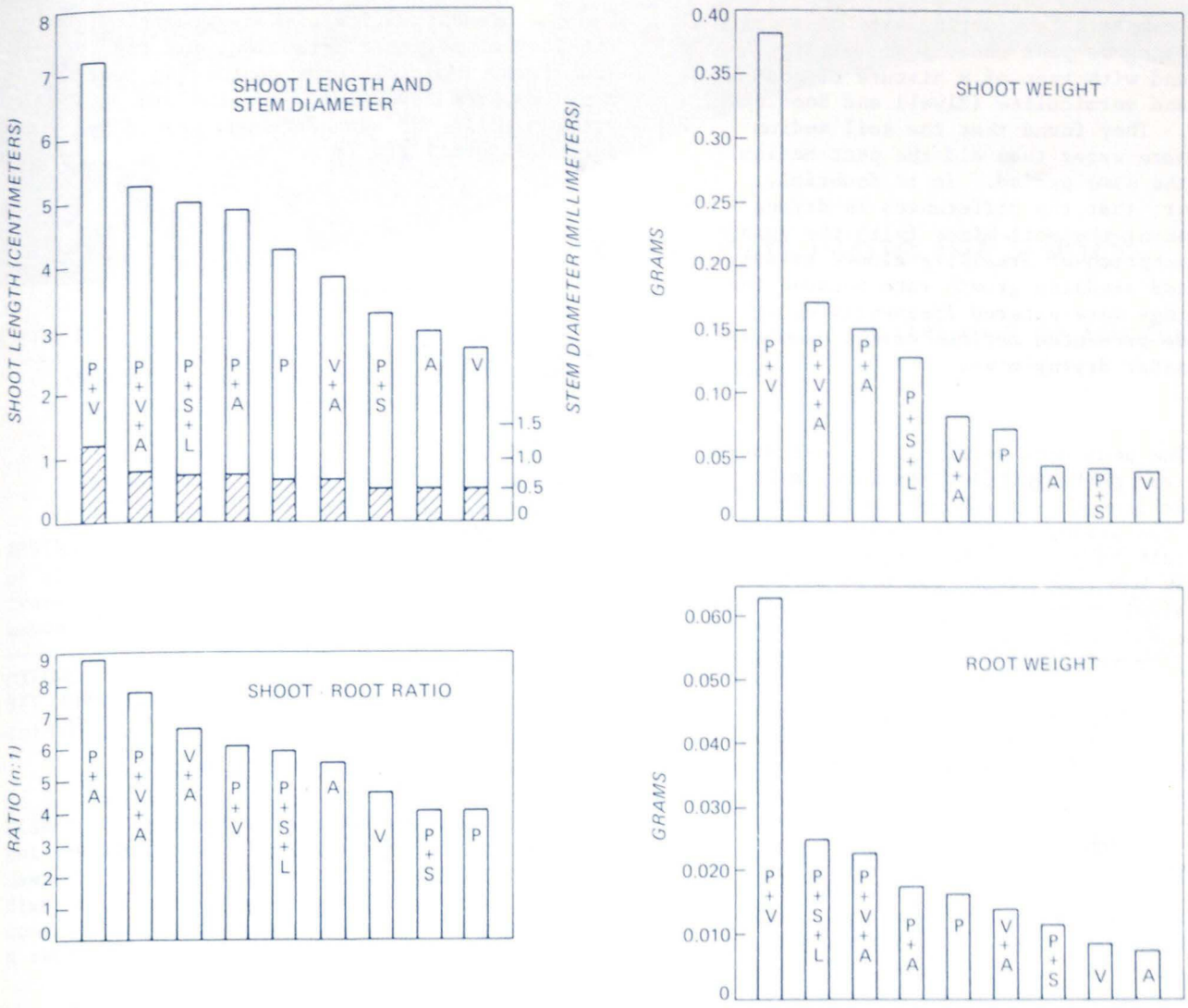

Figure 3.--*Average red pine seedling measurements from nine soil mixes in BC/CFS styrofoam containers (P = peat moss, V = vermiculite, S = sand, A = arcillite, and L = loam).*

peat moss alone. Other media, including the peat-sand-loam mixture, ranged from 6.3 to 7.0. The pH values of the four peat moss media mentioned above are close to the value of 5.4 recommended by Wilde (1946) for growing red pine in the nursery. However, growth differences cannot be explained solely on this basis because seedlings in the potting soil, which had a relatively high pH, performed at least as well as those in some media that had lower pH values.

The relative drying rates were determined for the mixes by saturating with water a sample of each mix in styrofoam pots, allowing it to drain, and recording electrical resistances over a period of several weeks by means of plaster of Paris blocks. Peat moss and vermiculite retained moisture the longest. Arcillite alone and mixed with either vermiculite or peat moss dried rapidly. Other mixes, including the potting soil, showed intermediate rates of drying. These results corroborate another

study comparing the drying rate of a soil consisting of peat moss, loam, perlite, and sand with that of a mixture of peat moss and vermiculite (Elwell and Boodley 1967). They found that the soil medium lost more water than did the peat medium over the same period. It is doubtful, however, that the differences in drying rate among the soil mixes (with the possible exception of arcillite alone) greatly affected seedling growth rate because the seedlings were watered frequently enough to have prevented serious stress even in the faster drying mixes.

The peat moss-vermiculite, peat moss-sand, and potting soil mixes were easily removed from the styroblock containers. Mixes containing arcillite were the most difficult to remove. Retention of the soil on the root system was best with peat moss-vermiculite, peat moss-arcillite, and peat moss alone. Vermiculite and arcillite alone, or in combination had poor retention.

Differences in foliage color among the treatments were also evident. There were more seedlings with chlorotic needles in the peat moss and sand mix and in the medium containing only peat moss. The paper pot containers had fewer chlorotic seedlings than the styrofoam containers.

This study shows that different soil media may have widely different effects on the growth of tree seedlings grown in containers, even though other conditions remain constant. Of the mixes studied, peat moss and vermiculite produced the largest red pine seedlings. This mixture had the highest cation exchange capacity, the longest moisture retention, and the lowest pH. Most mixtures containing peat moss compared favorably with standard potting soil. No advantage was gained by including arcillite in any mix.

LITERATURE CITED

Elwell, R. N., and J. W. Boodley. 1967. A comparison of bedding plant containers. N.Y. State Flower Grow. Bull. 256, 5 p.

Funk, D. T. 1971. Pot size, pot shape, and soil mix all influence black walnut seedling growth. Plant Propagator 17(1): 10-14, illus.

Scarratt, J. B. 1972. Container size affects dimensions of white spruce, jack pine planting stock. Tree Plant. Notes 23(4): 21-25.

Wilde, S. A. 1946. Forest soils and forest growth. 241 p. Waltham, Mass.: Chronica Botanica.

Wildon, C. E., and F. L. S. O'Rourke. 1964. The effect of arcillite in media for pot plants. Mich. State Univ., Agric. Exp. Stn., Res. Pap. 16, 4 p.

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